This listing of claims replaces all prior versions of claims in the Application.

Listing of Claims

Claim 1.   (Currently Amended) A method for determining the quantity of both brightener and leveler in an electroplating bath <u>having an unknown quantity of brightener and leveler</u> comprising the steps of:

a)   determining the amount of brightener <u>in the electroplating bath having the unknown quantity of brightener and leveler</u> by a method selected from cyclic voltammetric stripping and cyclic pulse voltammetric stripping;

b)   obtaining a plurality of plating baths where each bath has a known and different quantity of said brightener and leveler, but where the quantity of each in each bath differs from the quantity in the other baths;

c)   for each bath, providing a counter electrode, a cleaned working electrode and a reference electrode immersed in said bath, and carrying out a predetermined sequence of steps comprising:

1.   cleaning and oxidizing the surface of the working electrode at a fixed potential for a period of time;

2.   equilibrating said working electrode to absorb brightener according to a step selected from equilibrating without energy input for a time until the change in energy output with time is minimal and equilibrating for a set time at a fixed potential;

3.   plating metal ions on said working electrode with energy input for a time selected from a time sufficient to measure initial plating energy output <u>and, a time sufficient to measure the change in energy output with time</u>; and

4.   ~~optionally continuing to plate metal ions for a time sufficient to measure the change in energy output with time;~~

~~5~~<u>.4.</u>   stripping at a potential and for a period of time sufficient to remove the metal ions plated in steps 3 ~~and 4~~;

d)   for each bath, correlating the quantity of leveler with the energy output value obtained in step 3 ~~or 4~~;

e)   ~~obtaining a plating bath having an unknown quantity of brightener and leveler,~~ placing said electrodes in said <u>electroplating</u> bath <u>having the unknown quantity of brightener and leveler</u> and performing said predetermined sequence of steps;

f)   choosing from said correlations in step d), a particular correlation for a bath containing substantially the amount of brightener determined in step a); and

g)   choosing from the particular correlation in step f), a quantity of leveler which corresponds to said energy outputs recorded for said <u>electroplating</u> bath ~~with~~<u>having</u> the unknown quantity of brightener and leveler.

Claim 2.   (Original) The method of claim 1 wherein the electroplating bath is a copper electroplating bath.

Claim 3.   (Original) The method of claim 1 wherein the working electrode is a platinum electrode.

Claim 4.   (Original) The method of claim 1 wherein the electrode is a rotating disk electrode.

Claim 5.   (Currently Amended) A method for determining the quantity of both brightener and leveler in an electroplating bath <u>having an unknown quantity of both brightener and leveler</u> comprising the steps of:

a)   obtaining a plurality of plating baths, where each bath has a known and different quantity of said brightener and leveler, but where the quantity of each in each bath differs from the quantity in the other baths;

b)   sweeping for each of said baths an inert, working electrode at a predetermined rate through a plurality of voltammetric cycles until a condition of steady state is obtained, each of said voltammetric cycles including a metal plating range and a metal stripping range for each of said baths of said plurality of baths, each of said voltammetric cycles comprising a sweeping of a voltage toward one polarity followed by a sweeping of said voltage toward a reverse of said one polarity to complete said cycle;

c)   measuring the coulombs utilized during said metal stripping range of said cycle for each of said baths of said plurality of baths, whereby a correlation is obtained between the effective quantity of brightener and said coulombs utilized during said metal stripping range;

d)   ~~obtaining a~~providing the electroplating bath having ~~an~~the unknown quantity of both brightener and leveler;

e)   sweeping for said ~~unknown~~bath having the unknown quantity of both brightener and leveler an inert, working electrode at said predetermined rate through a plurality of voltammetric cycles until a condition of steady state is obtained, each of said voltammetric cycles including a metal plating range and a metal stripping range for said electroplating bath having ~~an~~ the unknown quantity of both brightener and leveler, each of said voltammetric cycles comprising a sweeping of a voltage toward one polarity followed by a sweeping of said voltage toward a reverse of said one polarity to complete said cycle;

f)   measuring the coulombs utilized during said metal stripping range of said cycle for said electroplating bath having ~~an~~the unknown quantity of both brightener and leveler;

g)   choosing from said correlation a quantity of brightener which corresponds to said coulombs utilized for said electroplating bath having ~~an~~the unknown quantity of ~~organic leveling agent~~ both brightener and leveler;

h)   for each of said plurality of plating baths in step a), providing a counter electrode, a cleaned working electrode and a reference electrode immersed in said bath, and carrying out a predetermined sequence of steps comprising:

1.   cleaning and oxidizing the surface of the working electrode at a fixed potential for a period of time;

2.   equilibrating said working electrode to absorb brightener according to a step selected from equilibrating without energy input for a time until the change in energy output with time is minimal and equilibrating for a set time at a fixed potential;

3.   plating metal ions on said working electrode with energy input for a time selected from a time sufficient to measure initial plating energy output and a time sufficient to measure the change in energy output with time; and

4.   optionally continuing to plate metal ions for a time sufficient to measure the change in energy output with time;

5.4.   stripping at a potential and for a period of time sufficient to remove the metal ions plated in steps 3 and 4;

i)   for each bath, correlating the quantity of leveler with the energy output value obtained in step 3 or 4;

j)   obtaining a plating bath having an unknown quantity of brightener and leveler, placing said electrodes in said electroplating bath having the unknown quantity of both brightener and leveler and performing said predetermined sequence of steps;

k)   choosing from said correlations in step i), a particular correlation for a bath containing substantially the amount of brightener determined in step g); and

l)   choosing from the particular correlation in step k), a quantity of leveler which corresponds to said energy outputs recorded for said electroplating bath with having the unknown quantity of brightener and leveler.

Claim 6.   (Original) The method of claim 5 wherein. the electroplating bath is a copper electroplating bath.

Claim 7.   (Original) The method of claim 5 wherein the working electrode is a platinum electrode.

Claim 8.   (Original) The method of claim 5 wherein the electrode is a rotating disk electrode.

Claim 9.   (Currently Amended) A method for determining the a quantity of leveler in an electroplating bath without first determining a quantity of brightener in the electroplating bath comprising the steps of:

a)   obtaining a plurality of plating baths where each bath has a known and different quantity of brightener and leveler, wherein the quantity of leveler in each bath differs from the quantity in the other baths and wherein the quantity of brightener in each bath is the same;

b)   for each bath, providing a counter electrode, a cleaned working electrode and a reference electrode immersed in said bath, and carrying out a predetermined sequence of steps comprising:

1.   cleaning and oxidizing the surface of the working electrode at a fixed potential for a period of time;

2.   equilibrating said working electrode to absorb brightener according to a step selected from equilibrating without energy input for a time until the change in energy output with time is minimal and equilibrating for a set time at a fixed potential;

3.   plating metal ions on said working electrode with energy input for a time selected from a time sufficient to measure initial plating energy output and a time sufficient to measure the change in energy output with time; and

4.   ~~optionally continuing to plate metal ions for a time sufficient to measure the change in energy output with time;~~

~~5.~~4.   stripping at a potential and for a period of time sufficient to remove the metal ions plated in steps 3 ~~and 4~~;

c)   for each bath, correlating the quantity of leveler with the energy output value obtained in step 3 ~~or 4~~;

d)   obtaining a plating bath having an unknown quantity of leveler;

e)   diluting the bath having ~~an~~ the unknown quantity of leveler with a leveler-free composition comprising a fixed concentration of brightener and placing said electrodes in said bath having the unknown quantity of leveler and performing said predetermined sequence of steps;

f)   choosing from said correlation in step c), a quantity of leveler which corresponds to said energy outputs recorded for said bath with the unknown quantity of leveler;

wherein the leveler is a reaction product of an amine with an epoxide.

Claim 10.   (Original) The method of claim 9 wherein. the electroplating bath is a copper electroplating bath.

Claim 11.   (Original) The method of claim 9 wherein the working electrode is a platinum electrode.

Claim 12.   (Original) The method of claim 9 wherein the electrode is a rotating disk electrode.